federal register

Monday
July 6, 1981

Part III

Water Resources Council

Synthetic Fuels Development for the Upper Colorado Region Water Assessment

WATER RESOURCES COUNCIL

Synthetic Fuels Development for the Upper Colorado Region Water Assessment

AGENCY: Water Resources Council.

ACTION: Notice of water assessment report for public review and comment.

SUMMARY: This notice incorporates the water assessment report prepared by the Water Resources Council under the provisions of Section 13(a) of the Federal Nonnuclear Energy Research and Development Act of 1974.

DATE: Comments on this report are due on or before October 5, 1981. A 90-day comment period is provided by law; however, because the water Resources Council will be terminated September 30, 1981, the staff may not have time to respond to and formally incorporate comments into the official WRC analysis submitted to the Secretary of Energy. Interested person are, therefore, urged to submit comments before September 1, 1981.

Reference for comments

This summary report only highlights important aspects of the full technical report. Therefore, reviewers should use the full tcchnical report for comment. For copies of the technical report contact: Joyce Doherty, U.S. Water Resources Council, 2120 L Street, NW., Washington, D.C. 20037. Phone: 202/254–6352.

ADDRESS: Send comments to: Gerald D. Seinwill, Acting Director, U.S. Water Resources Council 2120 L Street, NW., Washington, D.C. 20037.

FOR FURTHER INFORMATION CONTACT: Frank S. Davenport, Program Leader, or Joyce Doherty, Staff Specialist, U.S. Water Resources Council, 2120 L Street, NW., Washington, D.C. 20037, phone: 202/254–6352.

Dated: June 29, 1981.

Gerald D. Seinwill,

Acting Director.

I. Preface

The U.S. Water Resources Council (WRC) staff has prepared this report under the provisions of paragraph (a) of Section 13 of the Federal Nonnuclear Energy Research and Development Act of 1974, as amended. The report is the result of an assessment of water requirements, water supply availability, and other water implications of synthetic fuels development in the Upper Colorado River Region. Under a memorandum of agreement with WRC, the Colorado Department of Natural Resources managed the regional assessment and published a regional report entitled *The Availability of Water for Oil Shale and Coal Gasification Development in the Upper Colorado River Basin.* That report serves as the principal basis for this report and supporting technical reports, which are available on request from the U.S. Water Resources Council.

Publication of the report in the **Federal Register** is mandated under the provisions of Section 13 to enable public review and comment during a 90-day period. Comments on the report are to be submitted to: Gerald D. Seinwill, Acting Director, U.S. Water Resources Council, 2120 L Street, NW., Washington, DC 20037.

After the 90-day review period, the WRC staff will analyze the comments received and will revise the report as appropriate. WRC will forward the comments, the WRC analysis, and the final water assessment report to the Secretary of the U.S. Department of Energy.

A. Purpose of Report

The purpose of the report is to describe the availability of water to support the production of synfuels through coal and oil shale conversion technologies and to identify major effects that synfuels development could have on the water resources of the Region.

The report is intended to support national and regional energy supply planning and decisionmaking. It is also designed to serve water resources managers and decisionmakers in the conception, implementation, and operation of water management measures and programs needed to support energy development.

The report was not prepared nor was the assessment designed to address site-specific questions. Therefore, users of the report are cautioned not to interpret information as applicable to specific sites.

B. Authorization

The Federal Nonnuclear Energy Research and Development Act of 1974, as amended, authorizes an extensive and accelerated program for research and development of nonnuclear energy technologies that will lead to full-scale commercialization by socially and environmentally acceptable means. Within the Act, Congress expressed a strong concern about the possible water resources implications of new energy technologies. The governing principles of the Act state: "Any program for the development of a technology which may require significant consumptive use of water after the technology has reached the stage of commercial application shall include thorough consideration of the impacts of such technology and use on water resoources pursuant to the provisions of Section 13." Subsection (a) of Section 13, the authorization fcr this report, provides that the U.S. Water Resources Council shall conduct water assessments for such nonnuclear energy technologies.

C. Objectives of Assessment

The assessment objectives were:

(1) To assess water supply availability for production of synfuels through coal and oil shale technology development.

(2) To assess the water and related land resources implications of such development, including determinations of (a) water requirements, (b) effects on water quality, (c) costs of water supplies, (d) costs of wastewater disposal, and (e) environmental, economic, and social impacts of water use.

(3) To provide DOE and other energy interests with information useful for the development of nonnuclear energy research, demonstration, and development (commercialization) programs.

II. Summary of Major Findings

A. Water Requirements

Synfuels development will increase the annual consumptive water use in the Upper Colorado Region by about 150,000 acre-feet per year for each million barrels (oil equivalent) per day of production.

B. Water Supply Availability

The Region's total water resources will be able to support nearly 3 million barrels of oil equivalent synfuels production per day.

Synthetic fuels development in some development areas will be limited unless additional water supply measures (i.e., reservoirs, water imports, groundwater) are developed. The White River area in Colorado and Utah with large oil shale reserves is of particular concern.

Provisions of the Compact among the Upper Basin States, which allocates water supplies among the States, may ultimately constrain synfuels development. Specifically, conversion of coal mined from the Four Corners area in New Mexico and both coal and oil shale conversion in Colorado, may ultimately be limited by these constraints.

C. Water Quality Effects

Wastewaters from synthetic fuels development will be minimal. These will

be disposed of through evaporation with no impact on surface waters.

Depletions of surface water by consumptive use of synthetic fuels may actually lower the concentrations of dissolved solids in surface waters in the Upper Basin since they will be removed during diversion and retained in evaporation ponds. However, the Lower Basin salinity problems will be somewhat increased by the combined Upper and Lower Basin depletions.

D. Environmental Effects

One important environmental concern associated with synfuels water use is the potential adverse effects on habitats of two endangered fish species, the Colorado Squawfish and the Humpback Chub.

Other environmental effects appear limited to local or site-specific situations involving reservoir development and diversion facilities, which would require site-specific analyses.

E. Economic and Social Effects

A synthetic fuels production of nearly 3 million barrels per day would reduce hydroelectric power revenues by $6 to $7 million annually.

Increased salinity concentration in the Lower Basin would adversely effect agricultural production by $4.3 million annually.

F. Water Supply Costs

The investment costs in water supply development facilities for 3 million barrels per day of synfuels production is estimated between $0.9 and $1.6 billion or approximately 2 percent of the capital investment in synfuels facilities. Most would occur in the White River area.

G. Need for Continuing Improvement in Water Management

The Colorado River system is a complex water management system involving interests inside and outside both the Upper and Lower Basin, including municipal water supply in Los Angeles, San Diego, Denver, and Phoenix. The complexity is illustrated by: interstate compacts; an International Treaty; Supreme Court decrees; growing regional economic activity; energy, agricultural and environmental resources of national and worldwide importance; immense Federal investments in water development; and continuing evolution of new water management problems, challenges, and resolutions.

A synthetic fuels industry within the Region that would annually deplete several hundred thousand acre-feet of water would add to the complexity of Basin management.

The following measures are needed to improve water management in the Basin:

(1) Greater coordination between Federal and State programs and water, energy, and land use agencies.

(2) Subbasin water management plans responsive to synfuels development needs but multipurpose in scope and formulated on an intrastate basis, except where interstate considerations are necessary.

(3) Timely water management decisions that balance competing environment and development interests.

(4) Improve communication among analysts, the public, the energy industry, and water resource decisionmakers.

(5) Expansion of data collection, particularly for groundwater in energy resource areas.

These measures should be achieved under or evolve from the responsibilities of existing water institutions.

III. Background

A. Management of Assessment

Operational managment of the regional assessment was provided by the Colorado Department of Natural Resources under an agreement with WRC. An Advisory Committee composed of the Upper Basin States and Federal agencies provided the overview. Major portions of the full assessment were provided by each State and by the U.S. Fish and Wildlife Service, U.S. Geological Survey, the U.S. Bureau of Reclamation, and the U.S. Department of Energy. The Bureau analyzed for WRC what effects the synfuels development in the Upper Basin would have on water uses in the Lower Basin. Consultants under contract to Colorado performed various components of the assessment.

The public had input to the assessment through review of and comment on the draft regional assessment report prepared by Colorado and through public workshops held in Grand Junction and Denver, Colorado. An interagency Federal briefing on the draft report also provided opportunity for informal and formal comment.

WRC prepared this report and the supporting technical report from results of the above efforts.

B. General methodology

Much of the assessment data was obtained from previously published reports of Federal and State agencies. Estimated hydrologic impacts in the main stem of the Colorado River were derived through the Colorado River System Simulation (CRSS) model of the U.S. Bureau of Reclamation.

For this assessment, water requirements (assumed to be consumptive use) for synfuels development include water for conversion processes, wet cooling, related facility operations, and a variety of secondary requirements. Examples of the latter include water supplies to support associated population growth and expanded industrial activity, revegetation of areas either surface mined or covered with mine spoil, and electric power requirements.

C. Overview of Upper Colorado Region

The Upper Colorado River Region includes the Upper Colorado River Basin and the Great Divide Basin, a total area of approximately 113,470 square miles, comprising about 45 percent of the entire Colorado River Basin (figure 1).

BILLING CODE 8410-01-M

Fig. 1 — Upper Colorado River Basin

BILLING CODE 6410-01-C

One-third forested, the Region is characterized by mountains, plateaus, and valley basins. Mountains form a perimeter on the east, west, and north. The dry climate exhibits wide variations in temperature due to seasonal changes and elevation differences.

Agriculture is the dominant land and water use, with mineral extraction the leading activity in dollars of output. The Region contains outstanding fish and wildlife habitats. Sport fishing, hunting, and year-around tourism and recreation also contribute to the Region's economy.

The Fedrral Government controls about 60 percent of the land in the Region, most of which is managed by the Bureau of Land Management. The remaining 40 percent is in private, tribal, and State ownership, in descending order. The area is sparsely settled. The 1975 population was about 438,000 people.

The Region's water resources serve an area much greater than that of the Upper Basin alone. Through transbasin diversions, the Upper Basin resources supply municipal and agricultural needs to the east, including the City of Denver, to the south (Upper Rio Grande Basin), and to the west (Central Utah Project). Outflows from the Upper Basin, under provisions of the Colorado River Compact, are the principal supply source for users in the Lower Basin and for transbasin diversions to users in Southern California and Nevada.

1. *Oil Shale Resources.* The Green River Formation (figure 2), the major oil shale source in the United States, was formed in ancient lakes of great depth. The thermal and chemical characteristics of the lakes allowed the deposition of thin-bedded oil shales and a number of relatively rare carbonate minerals. The formation is estimated to contain more than 3 trillion barrels of oil. Estimates for deposits thicker than 15 feet, yielding more than 15 gallons per ton, place Colorado's resources at 400 billion barrels, Utah's at 120 billion barrels, and Wyoming's at 12 billion barrels.

2. *Coal Resources.* The coals of the Upper Colorado Region constitute a major portion of total western coal reserves (Figure 3), with discoveries every year adding to the Region's potential. These generally good quality bituminous and subbituminous coals and an anthracite deposit in Gunnison County, Colorado, have desirable characteristics including low sulfur and ash contents and medium- to high-Btu values.

BILLING CODE 8410-01-M

Fig. 2 — Green River Oil Shale Formation

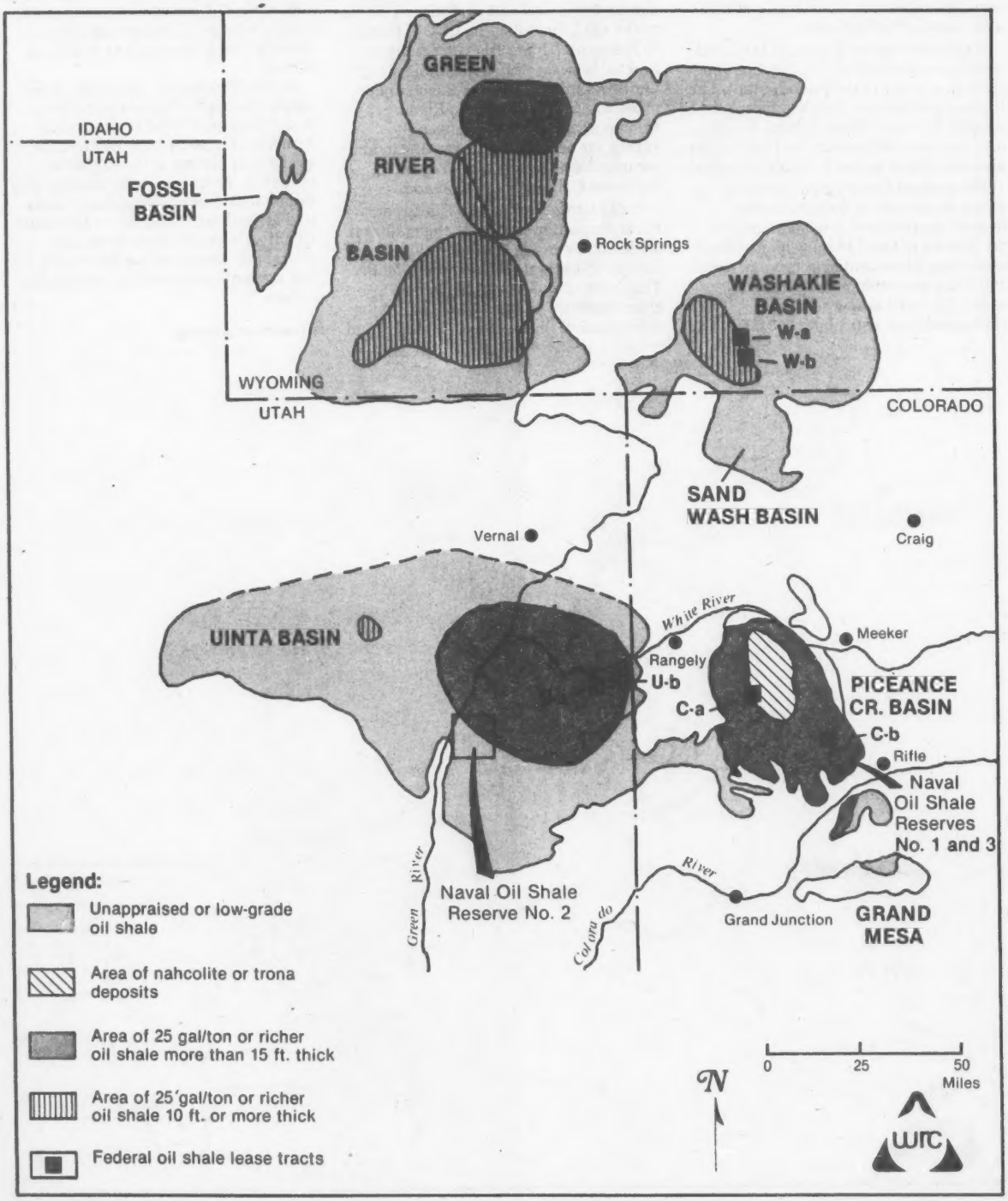
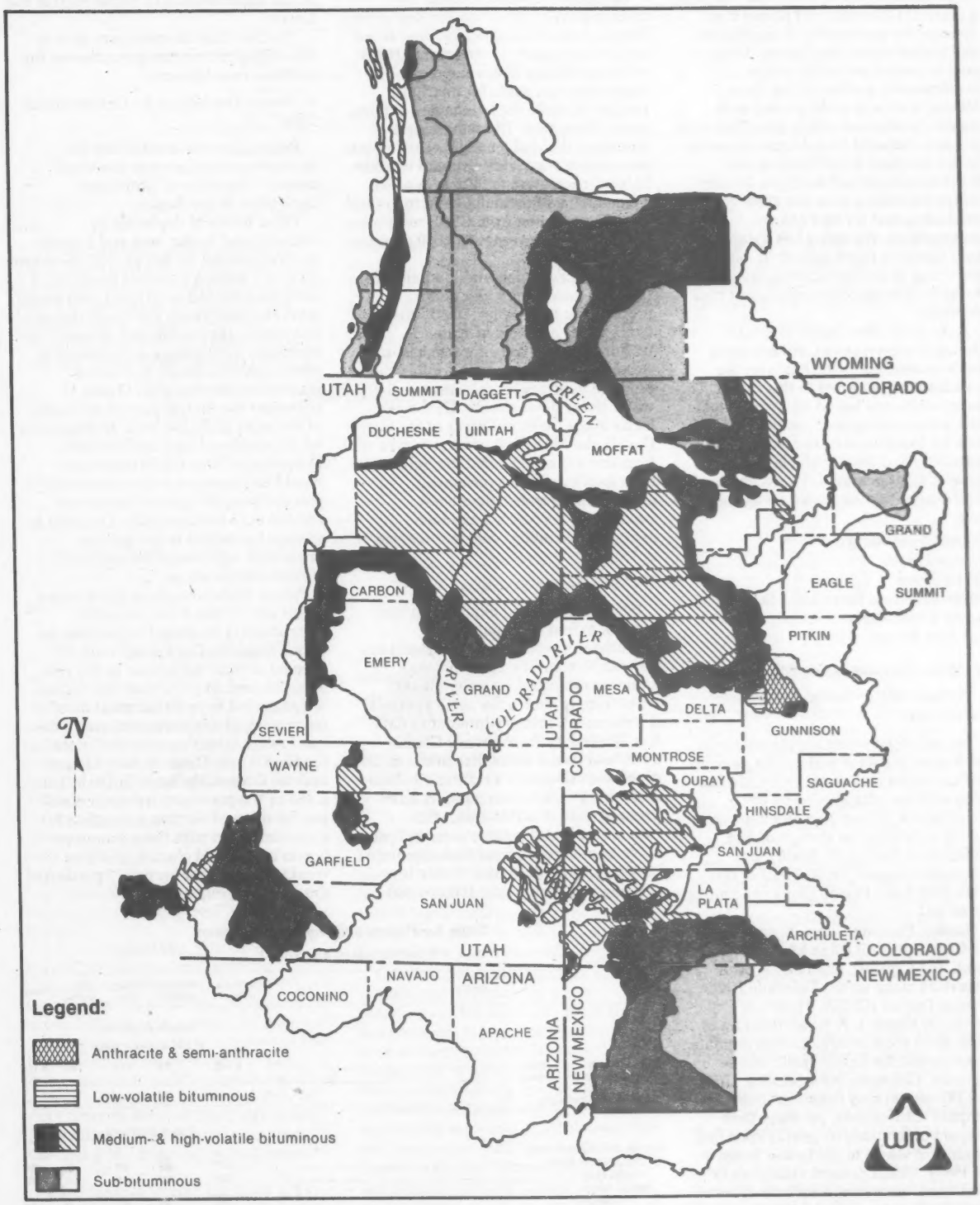


Fig. 3 — Upper Basin Coal Deposits



BILLING CODE 8410-01-C

Colorado's most significant coal deposits and mining are found in the northwestern part of the State. The high quality of Colorado coal places it in demand for steam electric generation and metallurgical appliations. Utah's coal is located primarily in the southcerntral portion of the State. Mining is mostly underground with current production about 10 million tons per year. Most of New Mexico's coal is in the San Juan River basin in the northwest corner of the State. Surface mines predominate in this area, producing coal for two nearby powerplants. Wyoming has extensive coal deposits; rapid growth in mining is occurring in the Rock Spring area. Arizona does not have significant coal deposits.

3. *Synfuels Development Areas.* During the assessment, six subareas were delineated as the basis for the conclusions presented in this report. The delineation was based on hydrographic and water management considerations and the location of base energy resources and their synfuels development potential. The synfuels development areas shown on figure 4 are:

Upper Green River
Yampa River
White River
Upper Colorado River Main Stem
Lower Green River
San Juan River

IV. Water Resources Conditions

A. Surface Water Resources (Present Conditions)

The principal water supply source in the Region is suface water. The natural surface water regime of the Region has been substantially altered by the construction of over 30 major reservoirs having a total active storage of 34.5 million acre-feet (maf). Main stem reservoirs account for 29.7 maf of this total, with Lake Powell alone accounting for 25 maf.

Navajo, Flaming Gorge, Fountenelle, the Curecanti Unit (Blue Mesa, Morrow Point, and Crystal), and Lake Powell reservoirs make up the Colorado River Storage Project (CRSP). These are shown on Figure 1. A major function of these main stem reservoirs is to regulate flows so that the Upper Basin States (Arizona, Colorado, New Mexico, Utah, and Wyoming) may consume their compact entitlements, yet meet their compact obligations to deliver specified amounts of water to the Lower Basin at Lee Ferry. Under present steady state conditions, the average volume of water available in storage in the CRSP system would be about 85 percent of the total active storage.

Depletions of surface water by consumptive uses within the Region and exports from the Region average about 3.12 maf annually under present (1975–1976) conditions of development. Agriculture accounts for nearly 70 percent of these depletions and exports about 25 percent. The remaining 5 percent is divided among thermal power generation, support of fish and wildlife habitat, recreation facilities, mineral extraction, and municipal and industrial uses. Evaporation from CRSP reservoirs is estimated to average 715,000 acre-feet annually.

Salt concentration and loadings are the most prevalent water quality problems in the Region. Due to the concentrating effects of water withdrawals for consumptive use or export and reservoir evaporation, the problem becomes more severe as the water flows downstream. Of the salt loads in the Colorado River at Hoover Dam (Lake Mead), 60 percent comes from natural sources and the balance from man's activities (primarily irrigation). Average annual salt concentrations below Lake Mead averaged 723 milligrams per liter (mg/l) in 1972.

B. Groundwater Resources

Because of limited exploration and use, the extent and quality of groundwater resources in the Basin are difficult to quantify. Nonetheless, groundwater could be a significant water supply source for some synfuels development. Primary interest to date has focused on the Piceance Creek structural basin, which lies in the midst of western Colorado's richest oil shale reserves. Two artesian aquifers have been evaluated in this area, with estimates of total volume ranging from 2.5 to 25 maf and annual recharge from 23,000 to 29,000 acre-feet. Yields from existing wells vary from 100 to 1,000 gallons per minute, and concentrations of dissolved solids range from 200 mg/l in the upper aquifer to 30,000 mg/l in the lower.

The San Juan development area in New Mexico also has groundwater for synfuels development.

C. Future Depletions for Conventional Uses

Regional water availability for synfuels production was assessed against a baseline of projected depletions in the Region.

Three levels of depletion by conventional water uses and exports were examined for the year 2000—a low level (4.1 million acre-feet per year), a medium level (4.5 maf/year), and a high level (4.8 maf/year). For the purposes of this report, the availability of water for synfuels development is discussed in relationship to the medium level. Projections for this level (Table 1) represent the States' current estimates of the most probable level of depletions by conventional uses and exports. Evaporation from CRSP reservoirs would be expected to decrease about 4 percent from the present estimated 715,000 acre-feet annually. The drop in storage levels due to the greater depletions will lessen the reservoir surface evaporation.

Future depletions show three major water use trends. First, irrigated agriculture is projected to continue to expand, accounting for just over 60 percent of total depletions in the year 2000. Second, exports from the Region are expected to increase, most notably for municipal and industrial use in the front range urban corridor in Colorado, the Rio Grande Basin in New Mexico, and the Bonneville Basin in Utah. Third, a 350 to 500 percent increase in water use for thermal electric generation is expected. Even with these increases, however, thermal electric facilities would still account for only 7 percent of the year 2000 depletions.

Table 1.—*Present and Projected Depletions*

[Without synfuels development]

Area	Agricultural uses	Thermal electric	Other uses	Exports	Total
	Present depletions (1,000 acre-feet/year)				
Upper Colorado River Basin	2,145	74	133	764	3,116
CRSP Reservoir Evaporation					715
Total Depletions					3,831
	Future depletions				
Snyfuels Development Area:					
Upper Green River	307	83	92	0	482
Yampa River	107	59	15	0	181
White River:					
Colorado	37	10	11	0	58
Utah	22	0	0	0	22

Table 1.—*Present and Projected Depletions*—Continued

[Without synfuels development]

Area	Agricultural uses	Thermal electric	Other uses	Exports	Total
Upper Colorado River:[1]					
Main Stem	432	1	34	753	1,220
Lower Green River	534	64	28	265	891
San Juan River:					
Colorado	201	5	9	3	218
New Mexico	346	56	37	108	547
Other Upper Basin Areas	750	33	60	20	863
Subtotals:	2,736	311	286	1,149	4,482
CRSP Reservoir Evaporation					685
Total Depletions					5,167

[1] Excludes the Gunnison River.

Table 2 contains estimated present and future surface water outflows from the selected synfuels development areas and from the Basin. Estimates of the outflows were derived from the depletions presented in Table 1 and from basinwide reservoir operation studies that used the Colorado River Simulation System of the U.S. Bureau of Reclamation. The period of hydrologic record was 1906–1974. It should be noted that the natural surface water supply for shorter periods within this overall period was less than the long-term average. For example, the estimated natural outflow from the Upper Basin for the period 1906–74 was 15.2 maf, whereas for the period 1937–74, it was 13.8 maf per year.

Table 2.—*Annual Present and Future Surface Water Outflows*

[1,000 acre-feet/year]

Area	Present outflows[1]		Future average[2] annual outflows
	Average	90 percent exceedence	
Snyfuels Development Area:			
Upper Green River	1,545	925	1,380
Yampa River	1,580	1,030	1,513
White River	520	371	487
Upper Colorado River Main Stem	4,580	2,980	4,322
San Juan River	1,754	782	1,371
Upper Colorado River Basin	11,193	8,230	10,030

[1] Based on period 1906–1974.
[2] Does not include effects of synfuels development.

D. Institutional Factors

The availability of water for synfuels development is affected by a series of complex institutional factors. For purposes of discussion, these may be grouped into four categories: the "Law of the River," State water rights laws, Federal and Indian reserved rights, and environmental regulatory laws and programs. The "Law of the River" includes an international treaty, interstate compacts, a U.S. Supreme Court decree, and several acts of Congress.

1. *Law of the River.* The Colorado River Compact is considered the cornerstone for water allocation in the Colorado River Basin. Negotiated by the seven basin States in 1922, the compact provisions include (1) separation of the Upper Basin from the Lower at Lee Ferry, Arizona, and (2) apportionment of 7.5 maf per year of the natural flow of the Colorado River at Lee Ferry to the Upper Basin for beneficial consumptive use and a like quantity to the Lower Basin.

The Mexican Water Treaty of 1944 guarantees Mexico 1.5 maf of Colorado River water subject to certain contingencies not pertinent to this assessment.

The Upper Colorado River Basin Compact, negotiated in 1948, apportions 50,000 acre-feet per year of Upper Basin water to Arizona and of the remainder 51.75 percent to Colorado, 11.25 percent to New Mexico, 23 percent to Utah, and 14 percent to Wyoming. The compact also provides that evaporation losses from reservoir storage used to meet the Upper Basin delivery obligations to the Lower Basin are charged against the Upper Basin apportionment.

Construction, authorization, and operational direction for major reservoirs in the Colorado River Basin are provided in four Congressional Acts. One of these Acts, the Boulder Canyon Project Act of 1928, apportioned Lower Basin waters among the States of California, Arizona, and Nevada. It also authorized construction of Hoover Dam and associated facilities. A 1963 U.S. Supreme Court decision upheld the apportionments in the case of Arizona vs. California.

Further interpretation of the Congressional Acts may ultimately affect water allocations from the Colorado River System. Only the statutory provisions of the Colorado River Basin Projects Act of 1968, however, have current relevance to the assessment. These provisions required the Secretary of the Interior to propose criteria for the Coordinated, long-range operation of major reservoirs in the System, including priorities for the storage and release of water. Such criteria have been developed and implemented, and are incorporated in the Basin hydrologic analysis used to reach conclusions on water supply availability.

2. *State Water Rights Law.* Surface water rights in Upper Basin States are based on the doctrine of prior appropriation. Under this doctrine, those who first take steps to divert and apply water to a beneficial use have a right that is senior to those who subsequently initiate action. Two basic types of water laws are involved. In Colorado, the right to make an appropriation is limited only by senior water rights. Thus, neither the

judicial nor the executive branch of State government has discretionary authority over the type, place, or quantity of use. The remaining Upper Basin States, however, use a permit system in which the State Engineer must approve the right to appropriate water. Here, the State Engineer may deny an application if it is determined to be contrary to the "public interest."

All Upper Basin States (1) allow water rights to be claimed as of the date the application was received, even though actual use is deferred for a period of years; (2) allow for the transfer of a water right from one use to another, one owner to another, or one location to another; and (3) disallow instream flow use as a basis for granting a private water right. Only Colorado law includes instream flow uses and provides for State acquisition of a water right in an amount necessary "to preserve the natural environment to a reasonable degree."

State laws governing the appropriation of groundwater have similarities. Colorado's procedures are probably the most stringent. Groundwater in Colorado is classified as either tributary or nontributary. Because tributary groundwater is hydraulically connected to a surface stream, it is included in the statutory definition of a natural stream and administered under the surface priority system. Nontributary groundwater, which is found in confined formations often under artesian pressure, is administered by the State Engineer through a permit system that limits the amount of annual withdrawal to 1 percent of the water in storage below the applicant's property.

3. *Federal and Indian Reserved Rights.* Title to various quantities of water is currently held by the Federal Government and a number of Indian tribes under the legal principles of Federal reserved water rights. Because these reserved rights are generally not being used, current water availability is little affected. Future reserved right claims and awards could, however, affect the availability of water for other purposes.

4. *Environmental Regulatory Laws and Programs.* A number of Federal laws and programs, although not directly involved with water allocation and use, indirectly affect potential development and/or its associated water implications. Those most pertinent to synfuels development in the Region are:

(1) Fish and Wildlife Coordination Act (P.L. 85–264)

(2) National Wild and Scenic Rivers Act (P.L. 90–542)

(3) Endangered Species Act (P.L. 93–205)

(4) Wilderness Act (P.L. 88–577)

(5) Clean Water Act (P.L. 92–500, as amended by P.L. 95–217).

In addition to the foregoing, the seven States of the Colorado River Basin have adopted a joint objective of maintaining salinity in the lower main stem of the Colorado River at or below the average value found during 1972, while continuing to develop their compact-apportioned waters. Numeric salinity criteria have been approved by each of the States and the U.S. Environmental Protection Agency at three downstream locations. Although subject to change, the criteria pose constraints on water use and development in the Upper Basin. The average normal salinity levels not to be exceeded are 723 mg/l below Hoover Dam, 747 mg/l below Parker Dam, and 879 mg/l below Imperial Dam, all in the Lower Colorado Basin.

V. Water Requirements for Synfuels Development

Estimated demands on Regional energy resources were developed by DOE through disaggregation of the national energy demand forecasts for the years 1985 and 2000. Two levels of synthetic fuels development in the Region were forecast—a baseline and an accelerated development level. The baseline case was based on the principal assumption that synfuels development would proceed according to a "business as usual" pace. The accelerated case was based on the assumptions that: synfuels development would substitute for a greater portion of domestic gas and oil and reduce foreign imports; would have Federal financial support; would have an optimistic degree of success in early market penetration; and production costs would make the product competitive.

A. Patterns of Synfuels Development

Hypothetical siting patterns were then developed for the projected levels of development according to location of oil shale and coal deposits and water availability. Table 3 shows the projected siting for the year 2000 for the baseline and accelerated case projections. Information for 1985 has been excluded because of the small scale of projected development and its relative unimportance to the overall questions of water supply adequacy and water-related impacts.

Table 3.—*Synthetic Fuels Development Patterns—2000*

Synfuels development area	Baseline case			Accelerated Case		
	Coal gasification (million scf/day)		Oil shale (bbl/day)	Coal gasification (million scf/day)		Oil shale (bbl/day)
	Low Btu	High Btu		Low Btu	High Btu	
Upper Green River	0	250	25,000	0	250	140,150
Yampa River	0	0	0	0	250	0
White River:						
Colorado	0	0	625,000	0	0	1,200,000
Utah	0	0	450,000	0	0	600,000
Upper Colorado River Main Stem	0	0	200,000	250	0	500,000
Lower Green River	0	0	0	0	250	0
San Juan River:						
Colorado	0	[1]375	0	0	[1]340	0
New Mexico		1,410	0	0	1,410	0
Totals	0	2,035	1,300,000	250	2,500	2,440,150

[1] Inconsistency due to rounding and similar factors in the national synfuels analysis.

B. Water Requirements for Unit-Sized Facilities

Water requirements estimates for unit-sized facilities were determined for each of the energy conversion processes under consideration. These estimates were based on available data from small-scale experimental facilities, theoretical calculations, and similar information. The estimates are general due to the wide range in water requirements among individual process technologies, varying efficiencies of cooling equipment, differences in air and water pollution control measures, and facility design options. Table 4 presents the range in water requirements for unit-sized synfuels facilities and the values selected for use in the assessment which assume zero return flows.

Table 4.—*Water Requirements for Unit-Sized Synfuels Facilities*

Technology	Facility	Water requirements (1,000 acre-feet/year)	
		Potential range	Adopted assessment value
Oil Shale Conversion	50,000 bbl./day	2–9	5.7
High-Btu Coal Gasification	250 million std. cu. ft./day	5–7.5	7.5
Low-Btu Coal Gasification	250 million std. cu. ft./day	3–14.5	13.5

Information presented in Tables 3 and 4 was then integrated to estimate annual water consumption for synfuels development in each development area. Estimates of water requirements for associated growth were added to include provision for water supplies for municipal industrial, and other purposes that may accompany synfuels development (Table 5).

Table 5.—*Annual Water Requirements—2000*

[1,000 acre-feet/year]

Synfuel development area	Baseline case			Accelerated case		
	Synfuels development	Associated growth	Total	Synfuels development	Associated growth	Total
Upper Green River	10.4	4	14.4	23.2	7	30.2
Yampa River	0	0	0	7.5	3	10.5
White River:						
Colorado	71.3	19	90.3	136.8	35	171.8
Utah	51.3	0	51.3	68.4	0	68.4
Upper Colorado River Main Stem	22.8	6	28.8	70	14	84
Lower Green River	0	4	4	7.5	7	14.5
San Juan River:						
Colorado	11.2	2	13.2	10.2	2	12.2
New Mexico	50	0	50	50	0	50
Totals	217	35	252	373.6	68	441.6

C. Wastewater Management for Synfuels Technologies

The wastewaters produced by synfuel facilities will come from water used for processing, cooling and sanitary purposes, and from surface runoff and mine drainage or dewatering. Under the assumption that wastewater effluent guidelines will be continued in their current form, disposal of the wastewaters will probably be through evaporation, ash disposal, shale compaction, and similar means, rather than by discharge to a surface stream.

1. *Coal Gasification.* Coal gasification facilities generate two separate wastewater streams—a blowdown stream of highly saline water from boiler makeup and cooling tower waters, and a process condensate stream containing various concentrations of ammonia, carbon dioxide, phenols, and other organics. If the process condensate stream is added to the cooling towers feedwater, the blowdown stream will contain both saline and organic contaminants.

These wastewater streams can be used for dust control if leachable salts, ammonia, and phenols are sufficiently reduced. Alternatively, the waste streams can be used to wet down the coal ash if the ash site is designed to prevent groundwater contamination. The estimated costs of disposing such wastewaters through appropriate use in evaporative cooling towers, dust control, and ash compaction are about 2.1 cents per million Btu of product output.

2. *Oil Shale Mining and Retorting.* Oil shale mining may require management of large quantities of brackish mine drainage water. The retorting will produce saline blowdown from boilers and cooling towers and process condensate water containing organics, i.e., waste streams similar to, though not identical with, those from coal gasification plants. The brackish mine water might be used, in whole or in part, as a supply source for plant cooling and process water. Excess mine water would have to be either reinjected underground or treated before discharge to a surface stream.

Depending on the process used to dispose of spent shale, significant quantities of wastewater could be used to moisten the shale after processing. One alternative for spent shale disposal would involve raising its in-place moisture content to convert the spent shale to a compacted, relatively impermeable and inert fill material, which would probably not contaminate surface streams or groundwater. This could consume all wastewater produced by the blowdown and process condensate streams.

The second alternative involves lining a valley with a thin, impermeable layer of compacted spent shale that is wetted down. The remainder of the spent shale would be deposited into the lined basin and compacted but not wetted down except for dust control. Since less than 1 percent of the spent shale would be wetted down, this alternative would use much less wastewater than the first alternative.

The cost estimates for treating wastewaters from shale oil processing facilities are similar to those for coal gasification plants.

VI. Water Supplies for Synfuels Development

Projected consumptive use requirements for synfuels and associated growth in 2000 under the accelerated case are about 440,000 acre-feet annually for the Region. This is about 10 percent of the year 2000 depletions by conventional water uses.

To assess water availability for synfuels development in the Region, the physical characteristics of water resources, possible alternative sources, and institutional factors affecting supply were examined. To determine water supply adequacy, average and monthly natural flows were adjusted for projected depletions by conventional uses at the outflow points of each development area. Natural flow estimates for the period 1906–1974 were used to define steady-state hydrologic conditions. During this period, the natural flow at Lees Ferry averaged 15.7 maf per year, with a low of less than 7 maf and a high of nearly 24 maf.

A. Alternative Means for Water Supply

Five alternative means of water supply for synfuels development were appraised. They are: (1) additional development of surface water resources, (2) the transfer of water supplies currently used for irrigated agriculture, (3) the development of groundwater resources, (4) weather modification to increase precipitation, and (5) the more efficient use of water supplies either exported from the Region for municipal use or used in the Region for irrigation.

1. *Development of Surface Water Supplies.* Much of the water required for synfuels development is likely to come from the additional development of surface water supplies. Additional development of surface supplies would entail the construction of new reservoirs, pipelines or canals, and pumping facilities. Where energy facilities are located along major rivers, they may be able to directly divert part of the river flow during higher flow periods. Reservoir storage would still be required to guarantee supplies during low-flow periods.

The estimated capital requirements to develop surface water resources for synfuels are shown in Table 6. The estimates are based on the assumption that all requirements would be surface supplied.

Table 6.—*Capital Requirements for Surface Water Development—2000*

[In millions of 1978 dollars]

Synfuels development area	Baseline case	Accelerated case
Upper Green River	50	100
Yampa River	0	15
White River	500	900
Upper Colorado Main Stem	150	350
Lower Green River		
San Juan River	200	200
Total	900	1,565

2. *Water Transfers from Irrigated Agriculture.* Substantial quantities of water could be obtained by acquisition of irrigation water rights. This would reduce the amount of water currently available for irrigation, the land area used in irrigated agriculture, and the amount of agricultural production. The number of farm units would also be reduced, as would be number of families deriving a living from agriculture. Such changes would be minor, however, compared to the other economic and demographic changes expected to shape social conditions in the Region even without synfuels development.

While legally possible in all five Upper Basin States, water transfers from irrigated agriculture will probably not occur except in the White River and Upper Colorado River main stem areas in Colorado. Synfuel companies have already purchased some water rights from agriculture at these locations. Estimated purchase costs for the water rights range from $500 to $2,000 per acre-foot. Additional costs will be incurred for pipeline and pumping from the diversion point to the synfuel facility. Transfers of irrigation water in the White River basin, however, could suppy less than half of the requirement for synfuels development in the accelerated case.

3. *Groundwater Development.* The vast majority of water used in the Region comes from surface sources. Because of costs, water quality problems, and other considerations, groundwater has not been used as a major supply source. In certain areas projected for synfuels development, however, groundwater could be a significant supply source for energy projects.

Although groundwater is found in many places, it has attracted interest as a supply source in only three locations where concentrated synfuels development coincides with potentially significant groundwater resources and insufficient surface supplies. These areas are the Piceance Creek structural basin, which underlies a portion of the White River and Upper Colorado main stem development areas in Colorado, the Uinta basin in northeastern Utah, and the San Juan development area in northwestern New Mexico. Of these, the Piceance Creek structural basin, which is projected for two-thirds of the oil shale development, has received greatest interest.

The year 2000 projections for this area indicate 94,000 acre-feet under the baseline case and 194,000 acre-feet of consumptive use under the accelerated case, exclusive of associated growth.

To supply the above water requirements from groundwater would require a capitalized cost of approximately $25 million for the baseline case and $60 million for the accelerated case. Since these costs are only 5 to 10 percent of the estimated costs to develop surface water supplies from the White River and Upper Colorado River main stem areas, the oil shale industry may find considerable advantage in using groundwater.

Under Colorado law, the rights of senior surface water appropriators must be protected from disruption of a groundwater system that discharges to a natural surface stream. For the Piceance Creek structural basin, the use of either the upper or the lower aquifer would be contingent upon the implementation of steps either to sustain the historic flow of the natural springs that discharge to Piceance and Yellow Creeks or to replace any water removed from the surface stream system.

Projected well field development and operation would not significantly affect regional income and population. Major groundwater pumping could deplete an essentially nonrenewable resource. At the moment, however, no other uses are foreseen for these groundwater supplies.

4. *Weather Modification.* Weather modification could be used to increase precipitation and the amount of surface runoff. Weather modification considerations were limited to winter orographic cloud seeding. Several experimental programs in the Region over the last two decades have increased precipitation 5 to 20 percent. However, the extent to which increased precipitation affects runoff and ownership of the increased supplies remains uncertain. In any event, increased runoff would at least improve the junior water rights.

Estimated costs per acre-foot of water generated through orographic cloud seeding range between $1 and $10. While this cost is very attractive, capturing and delivering water to synfuel facilities would cost about the same as those described for surface supplies.

Enhanced snowfall from weather modification would be advantageous to skiers, snow mobilers, and supporting businesses. However, increased snowfall raises costs for snow removal and avalanche control, increases the snow damage to orchards, reduces grazing potential for livestock and wildlife in high pastures, and raises costs for mining and timber operations. Because of these and other institutional factors, major weather modification is not likely in the near future.

5. *More Efficient Water Use.* The demand for the export of Regional water outside the Upper Colorado River Basin could be decreased thorugh improved municipal water use efficiency. Exports for municipal use (15 percent of projected depletions by conventional uses) are of greater interest for the year 2000 than in-basin municipal and industrial use (2 percent of projected depletions).

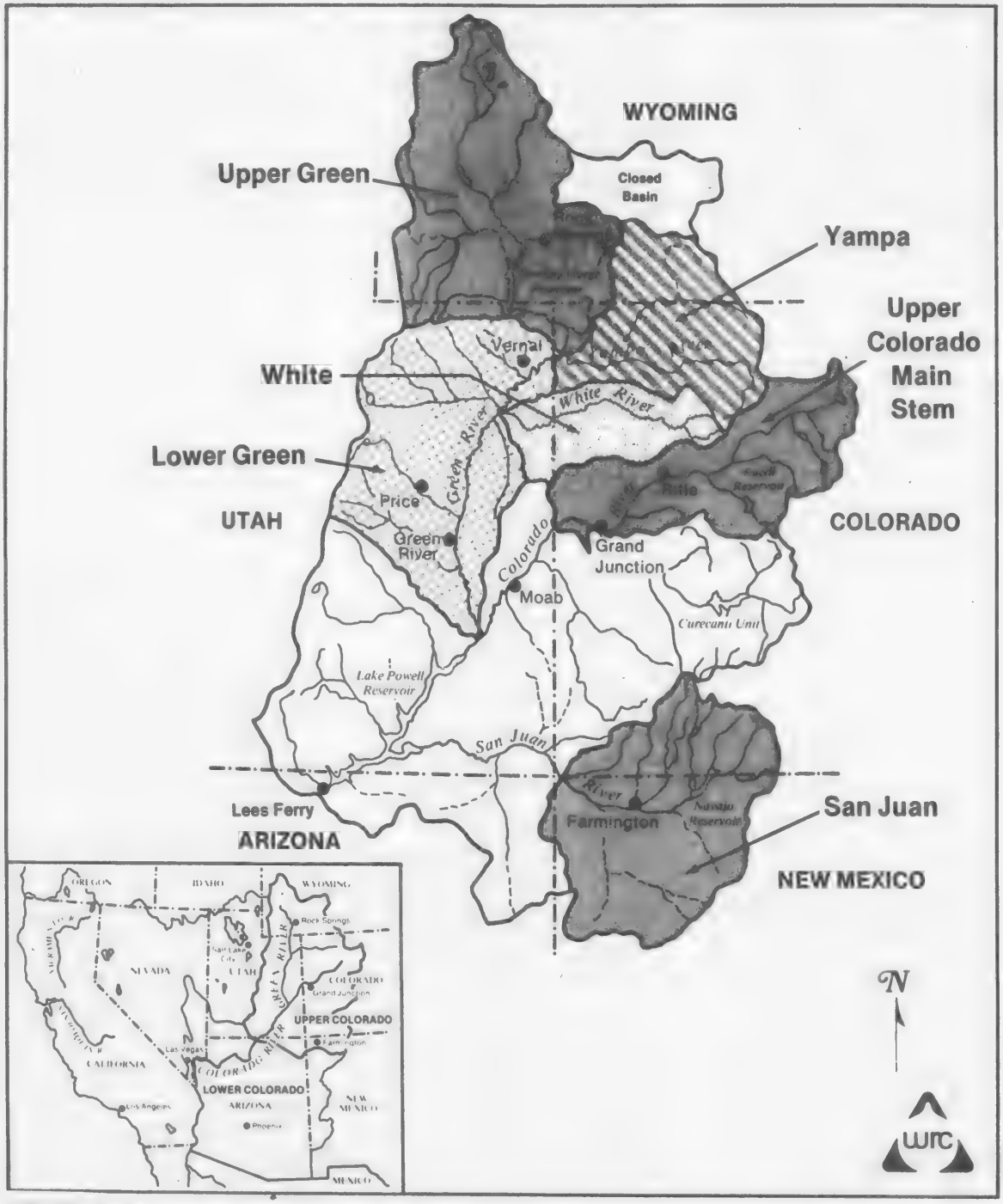
Techniques to reduce per capita use of municipal water include voluntary water conservation, education programs, regulations, metering, differential pricing, and wastewater recycling. According to recent studies, reductions of 30 to 40 percent may be possible without recycling. Conservation by one-half this amount (15 to 20 percent) could reduce the need for exports from the Basin by 100,000 to 135,000 acre-feet annually. At this time, however, successful implementation of conservation measures cannot be depended on as a means to increase water supply availability. Further, such measures would not affect supplies in the White River development area, which has the greatest water requirements for synfuels.

B. Water Availability in the Region

Determinations of water availability for synthetic fuels development in the year 2000 are summarized below for each synfuels development area and for the overall Region (Figure 4). Hydrologic aspects and possible institutional considerations of water availability are discussed for each area.

BILLING CODE 6416-01-M

Fig. 4 — Synfuels Development Areas



BILLING CODE 8410-01-C

1. *Upper Green River.* The estimated average annual natural flow at the outflow point of this area is about 2 maf. Average annual depletions are estimated at 317,000 acre-feet under present conditions and 482,000 acre-feet for future conventional uses. In 2000, synfuels production would deplete another 14,400 acre-feet under the baseline case and 30,200 acre-feet under the accelerated case. Since projected synfuels development under either case would require less than 2 percent of the average annual outflow from this area and since the area has already developed substantial water supplies (Fontenelle and Flaming Gorge reservoirs), only transport facilities are necessary to support water utilization. The level of future total depletions is well within Wyoming's compact entitlements.

2. *Yampa River.* The estimated average annual natural flow at the outflow point of this area is over 1.7 maf. Average annual depletions are estimated at 114,000 acre-feet under present conditions and 181,000 acre-feet for future conventional uses. Synfuel production would deplete another estimated 10,500 acre-feet under the accelerated case and none for the baseline case. Projected synfuels development would reduce average outflow from the area by less than 1 percent.

Facility siting will probably be in the Craig-Hayden area of Colorado. In this area during low-flow conditions, diversions may be precluded by downstream senior water rights. Therefore, a small amount of reservoir storage, not to exceed 5,000 acre-feet of active storage, would be needed. The level of future total depletions is within compact entitlements for the Yampa River.

3. *White River, Colorado and Utah.* The estimated average annual natural flow at the outflow point of this area is 568,000 acre-feet. Average annual depletions are estimated at 47,000 acre-feet under present conditions and 80,000 acre-feet for future conventional uses. In 2000, synfuel production would deplete another 141,000 acre-feet under the baseline case and 240,200 acre-feet under the accelerated case. There presently is no compact between Colorado and Utah allocating the surface waters of the White River.

The area has a sufficient overall water supply to support the projected levels of a synfuel development. However, analysis of seasonal low flows and dry years indicates that both levels of synfuels development will require substantial amounts of reservoir storage.

4. *Upper Colorado Main Stem.* The estimated average annual natural flow at the outflow point of this area is 5.7 maf. Average annual depletions excluding the Gunnison River drainage are estimated at 991,000 acre-feet under present conditions and 1.22 maf for future conventional uses. In 2000, synfuel production would deplete another 28,800 acre-feet under the baseline case and 84,000 acre-feet under the accelerated case.

Direct diversions from the Colorado River in the Grand Valley-DeBeque area could supply the projected synfuel development throughout most of the year, but the supply would be subject to downstream senior agricultural rights, which would occasionally curtail diversion. An estimated 15,000 to 35,000 acre-feet of active reservoir storage (depending on the synfuel development level) would be needed to ensure an adequate supply during these periods. Water could also be purchased from Federal reservoirs such as the Ruedi. Synfuels development below Grand Junction could utilize direct flow diversions. There are no specific interstate compact provisions for this area.

5. *Lower Green River.* The estimated average annual natural flow of this area as measured at Green River, Utah, is about 5.5 maf annually and includes the outflow of the Yampa and White Rivers and Upper Green River area. Average annual depletions within the area are estimated at 613,000 acre-feet under present conditions and 891,000 acre-feet for future conventional uses. In 2000, synfuels production would deplete another 4,000 acre-feet under the baseline case and 14,500 acre-feet under the accelerated case.

Flows in the Lower Green River are also reduced by depletions in upstream areas, the Upper Green River and the White and Yampa Rivers. Depletions in these upstream areas by conventional uses are projected to increase from 478,000 acre-feet annually under present conditions to 743,000 acre-feet annually in 2000. Depletions by synfuels development in these upstream areas are estimated at 156,000 acre-feet annually for the baseline case and 280,900 acre-feet annually for the accelerated case. The total 2000 depletions as measured at the outflow of the Lower Green River development area under the accelerated case would be less than 2 million acre-feet annually or about 35 percent of the natural flow.

Assumed coal gasification facilities in the development area could be located close to the Green River. Since the lowest monthly flows exceed 30,000 acre-feet, an adequate water supply should be available without supplemental reservoir storage.

6. *San Juan River Colorado and New Mexico.* The estimated average annual natural flow at the outflow point of this area is about 2.1 maf. Average annual depletions are estimated at 382,000 acre-feet under present conditions and 765,000 acre-feet for future conventional uses. In 2000, synfuel production would deplete 63,200 acre-feet under the baseline case and 62,200 acre-feet under the accelerated case.

Navajo Reservoir has over 48,000 acre-feet of water for sale. An additional 35,000 acre-feet has already been contracted for a proposed coal gasification facility. Developments sited in New Mexico would probably purchase water supplies from the Navajo Reservoir. The 12,000 acre-feet needed in Colorado could be obtained from the Piedra, Los Pinos, Florida, Animas, or La Plata Rivers, with some storage necessary on all but the Animas.

The total depletions in New Mexico under the accelerated case (conventional uses, synfuels development, and New Mexico's share of CRSP reservoir evaporation) will approximate the amount of water available to New Mexico under provisions of the Upper Basin Compact and with conservative hydrologic interpretation of waters available to the Upper Basin under provisions of the Colorado River Compact.

7. *Upper Basin Supplies.* Operation studies using the Colorado River System Simulation Model indicate that with Upper Basin depletions for conventional uses and CRSP evaporation of 5.17 million acre-feet annually in 2000, and with the annual 441,000 acre-feet consumptive use requirements of the accelerated case, the expected outflow from the Basin at Lees Ferry, Arizona, would exceed 9.6 million acre-feet. Moreover, the studies found that there was at least a 50 percent probability that the outflow in 2000 would exceed 8.23 million acre-feet. These findings indicate that synfuels development in the Upper Basin would not be constrained by the Colorado River Compact, at least up to the levels of development projected in the accelerated case. The operation studies assumed current U.S. Department of the Interior criteria for operation of CRSP reservoirs and other elements of the "Law of the River."

Water allocations of the Upper Basin Compact may constrain synfuels development in individual Upper Basin States. The situation in the San Juan River development area with respect to New Mexico has been mentioned.

Moreover, the aggregated depletions for Colorado in the Yampa River, White River, Upper Colorado Main Stem, and San Juan River development areas approximate Colorado's entitlement under conservative hydrologic assumptions.

C. Other Institutional Considerations

The institutional factors expected most to constrain water availability for synfuels development in the Region are the Endangered Species Act and the Wild and Scenic Rivers Act. Habitat of the Colorado River Squawfish and the Humpback Chub, two endangered species, occur in the Lower Yampa River, the White River, the Green River from its confluence with the Yampa to the Colorado Rivers, and the main stem of the Colorado River from its confluence with Plateau Creek to Lake Powell. Studies under the Wild and Scenic Rivers Act have been taken in headwater areas of the Piedra and Los Pinos Rivers in the San Juan River development area, the Ruby Canyon reach of the Upper Colorado main stem near the Colorado-Utah State line, and on the Yampa River within Dinosaur National Monument. The specific effects of any of these considerations on water supply availability or development cannot be appraised at this time.

The "first in time, first in right" principles and procedures will probably put synfuels development in a "junior" status for water supplies. However, this can be overcome if sufficient reservoir storage is constructed to regulate flows.

VII. Water Resource Impacts

A. Upper Colorado River Basin

1. *Water Quantity.* The impacts of synfuels development (accelerated case) on surface water quantity in the Upper Basin are presented on Table 7. The impacts were measured as a percent depletion of average annual outflows under natural and projected surface water conditions. Much higher percentages may be anticipated during the seasonal and dry-year low flows, although reservoir storage could be managed to maintain minimum instream flows. The greatest impact would be on the White River development area.

Table 7.—*Impacts of Synfuels Development on Surface Outflows*

[Accelerated Case—2000]

Synfuels development area	Percent of synfuels depletions	
	Natural outflow	Projected outflow [1]
Upper Green River	1.5	2.3
Yampa River	0.6	0.7
White River	42.5	49.5
Upper Colorado River Main Stem	1.5	2.0
Lower Green River [2]	5.9	7.6
San Juan	2.9	8.6
Upper Colorado River Basin	[3] 3.2	4.4

[1] Based on Table 2.
[2] Includes all synfuels depletions within upstream development areas.
[3] Based on period 1937–1974.

2. *Water Quality.* The potential magnitude of increased sediment loadings was examined by constructing annual suspended sediment budgets. In the examination, it was assumed that 3.6 acres of land would be disturbed per 1 million barrels of oil extracted from shale each year, 25 acres per 1 million tons of surface-mined coal, and 5 acres per 1 million tons of coal from underground mines. Table 8 presents the results of the suspended sediment analysis. The largest impacts are projected for the White River at Ouray, with an increase of more than 10 percent for the accelerated case.

Table 8.—*Suspended Sediment Loads—2000*

[Tons per year]

Location	Mean annual sediment load (1975)	Incremental sediment loading		
		Without synfuels	Baseline case	Accelerated case
Upper Green River at Green River, Wyoming	140,000	58,000	66,000	81,000
Yampa River near Maybell	420,000	31,000	31,000	35,000
White River near Ouray	1,170,000	4,000	84,000	146,000
Colorado River near Colorado-Utah Stateline	5,900,000	43,000	81,000	135,000
Lower Green River at Green River, Utah	8,300,000	5,000	85,000	155,000
San Juan River at Shiprock	6,620,000	28,000	42,000	42,000

Projected changes in dissolved solids concentrations from synfuels development were investigated through a mass-balance approach based on 1975 data. Zero return flows from synfuel facilities were assumed in line with the findings on wastewater management. Table 9 presents the results of this analysis. Total loadings show decreases, equalling almost 30 percent for the accelerated case on the White River near Ouray, as synfuels water use increases. The projections reflect depletions with and without synfuels development.

Table 9.—*Dissolved Solids Concentrations and Loadings—2000*

Location	Without synfuels		Baseline case		Accelerated case	
	(mg/l)	(1,000 tons/yr)	(mg/l)	(1,000 tons/yr)	(mg/l)	(1,000 tons/yr)
Upper Green River at Green River, Wyoming	415	681	414	673	412	665
Yampa River near Maybell	200	319			201	317
White River near Ouray	450	331	429	258	405	207
Colorado River near Colorado-Utah Stateline	568	3,828	569	3,615	569	3,582
Lower Green River at Green River, Utah	558	3,640	558	3,567	558	3,507
San Juan River at Shiprock	483	933	469	863	469	862

Projected downstream profiles of carbonaceous biochemical oxygen demand (CBOD) for the baseline and accelerated cases in the year 2000 were compared to CBOD profiles without snyfuels development for 1975 and 2000. The comparisons were based on 7-day, low-flow values with a 10-year recurrence interval. Since the analysis did not include the effects of new upstream reservoirs, it reflects worst case conditions.

Potential increases in CBOD loading from municipal wastewater treatment plants are most apparent in the White River Basin. The concentration of CBOD in the White River near Meeker, Colorado, reflects an increase of approximately 20 percent for the baseline case and about 80 percent for the accelerated case by the year 2000. Even larger increases—100 and 300 percent, respectively—were estimated for the White River near Rangely, Colorado, where large population increases would likely occur. Small CBOD changes were projected for the Colorado River main stem and the Yampa River development areas.

B. Lower Colorado River Basin Impacts

1. *Water Quantity.* The impacts of synfuel development under the accelerated case on flows in the Colorado River in the Lower Basin are shown on Table 10. As a result of synfuels development, water supplies would be reduced on all points of the

river. However, no downstream user would receive less than his actual legal entitlement. The Central Arizona Project would have the greatest reduction in supply because it holds significant but junior rights. The annual reduction is estimated at 88,000 acre-feet.

Table 10.—*Colorado River Average Annual Flows—2000* [1]

[1,000's acre-feet]

Case	Lees Ferry	Hoover Dam	Parker Dam	Imperial Dam	Mexico
Without synfuels	10,030	9,630	7,100	5,980	1,905
Accelerated Case	9,620	9,410	7,020	5,890	1,840

[1] With existing operating criteria for CRSP reservoirs.

2. *Water Quality.* Reduced flows to the Lower Basin would reduce the dilution effect and salinity concentrations would increase. Analysis of water quality impacts for the Lower Basin was limited to projected changes in salinity at Imperial Dam. For this determination, it was assumed that: (1) the first and second stages of the Las Vegas Wash Salinity Control Project would be in operation, removing 124,000 tons of salt annually; (2) the Grand Valley Project would be in operation with salt removal increasing from 34,000 tons in 1982 to 410,000 tons by 1990; and (3) the Paradox Project would be completed with salt removal of 180,000 tons annually. Increased salinity of 14.9 milligrams per liter would occur at Imperial Dam under the accelerated case.

VIII. Other Potential Impacts From Synfuels Development

A. Social And Economic Impacts

Population without synfuels in the Upper Colorado Region is projected to grow from 438,000 in 1975 to 1.1 million in 2000. Under the accelerated case, population would increase to about 3 million people. Most of the growth would be concentrated in 12 communities within six counties. Growth of this magnitude would have numerous impacts, including need for expanded municipal water supply and wastewater management systems, both with high capital investment requirements.

Depletions by synfuels development would decrease the water available for hydroelectric power generation at reservoirs in both the Upper and Lower Basins. For the accelerated case, reduced annual generation of 435 gigawatt hours can be anticipated. This reduction would mean a $13 million loss in annual revenues. These losses would be about evenly distributed between the Upper and Lower Basin.

The burden of reduced deliveries to the Central Arizona Project (88,000 acre-feet annually under the accelerated case) will probably fall on agricultural water users. However, agricultural production could be maintained through increased groundwater pumping, but with a net income loss of $1.1 million annually due to pumping costs. The total income loss is estimated at $2.5 million annually.

Economic impacts from increased salinity in the Lower Basin were assumed to be proportional to changes in salinity levels. An estimate $4.3 million (1976 dollars) of annual damages to agricultural, municipal, and industrial users were linked to the salinity increases.

B. Environmental Impacts

Projected effects on Upper Basin fish habitats from synfuels water depletions would be minimal except where impoundments convert stream fisheries to lake habitat, and for potentially serious adverse impacts on the Colorado Squawfish in the Utah reaches of the White River.

Recreational effects from synfuels surface water depletions in the Upper Basin were analyzed for the summer months only. The recreational qualities of most stream reaches would be unaffected by projected changes in flow. However, recreational opportunities in the Colorado River from Rifle, Colorado, to the Gunnison River; and the White River from Meeker, Colorado, to Ouray, Utah, would be reduced, but not eliminated.

No environmental impacts were identified in the Lower Basin as a result of projected changes in streamflows or salinity levels. Increased groundwater pumping in the service area of the Central Arizona Project would cause minor additional drawdown of the groundwater aquifer.

Conclusion

The production of synthetic fuels in the Upper Colorado River Basin by the extraction and processing of oil shale and/or coal, will require significant quantities of water. A synfuels production level of 3 million barrels per day (oil equivalent) would consume about 450,000 acre-feet of water annually (150,000 acre-feet per year per million barrels of daily capacity).

The overall supply of ground and surface water resources in the Region is sufficient to accommodate a synfuels production level of nearly 3 million barrels oil equivalent per day. This conclusion is reached after consideration of present and projected levels of conventional water uses (e.g., irrigation, water exports) and the several institutional arrangements that govern use and management of the Region's water supplies.

While the gross water supplies in the Region are sufficient for the accelerated synfuel development case, water supply problems are apparent in some synfuels development areas. Of particular concern is the White River development area in Colorado and Utah. This area contains the richest oil shale reserves in the Region. But because of lack of reservoir storage, surface water supplies in this area are subject to seasonal low flows and periodic droughts. In order to provide dependable water supplies in this area, the development of major reservoirs and other water supply facilities will be required.

Additionally, water uses by synfuels development in Colorado and New Mexico, in combination with projected conventional uses, will raise the annual depletions in these States to amounts close to their compact entitlements.

Because each State is well aware of this situation, the States can be expected to manage water use as needed and in cooperation with the Upper Basin Compact Commission.

Conflict with other water uses is possible. Instream uses, including water quality management, recreational boating, and fishery habitats, could be adversely affected by surface water depletions for synfuels development. Conflict over water rights and the respective priorities for use during dry periods is also possible. However, through continuing planning for water management and the timely implementation of planning recommendations, many of these conflicts can be avoided.

Since the analysis of impacts presumed that water supplies would be taken for synfuels production after projected conventional offstream uses in the Upper Basin were accommodated, no significant adverse impacts on these uses were found. However, depletions by synfuels will (1) reduce hydroelectric power production, (2) reduce deliveries to the Central Arizona Project, and (3) increase salinity in the main stem of the Colorado River in the Lower Basin. The economic value of these impacts are estimated at about $20 million annually.

While the assessment provides very positive findings on water supply availability and minimal adverse impacts, several factors must be viewed with caution. The Colorado River is presently utilized fully. Depletions in the Upper Basin are already over 27 percent

of the natural water supply. With projected conventional uses, water depletions will increase to 37 percent of the supply. A 3-million barrel per day synfuels industry would deplete about 3 percent of the supply; with this added to conventional uses, the total depletions would be over 40 percent of the Upper Basin supply. As depletions increase, the intensity of water management must also increase since the implication is that every drop of water must be used close to its full potential. This particularly true during the annual dry season and periodic droughts, which may last several years.

Institutionally, the Colorado River system is complex. Synfuels development will pose new challenges to the existing water management structure at all levels—international, State/Federal, interstate, intrastate, and local. Increased coordination among the various governing bodies will be needed to ensure that the necessary water management will be achieved. This coordination should also extend to land management agencies, particularly where use of public lands for energy development is involved. Individual States can and should serve as a focal point to strengthen planning, coordination, and implementation of water and land use management. Interstate cooperation can be achieved through existing institutions. Individual States can and should also maintain liaison with the development plans of the synfuels industry as well as provide for public awareness and discussion of water management options.

[FR Doc. 81-19588 Filed 7-2-81; 8:45 am]
BILLING CODE 8410-01-M